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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

REPORT ON THE UNITED NATIONS/UNITED STATES OF AMERICA INTERNATIONAL CONFERENCE ON SATELLITE REMOTE SENSING FOR RESOURCE MANAGEMENT, ENVIRONMENTAL ASSESSMENT AND GLOBAL CHANGE STUDIES: NEEDS AND APPLICATIONS OF DEVELOPING COUNTRIES

(Boulder, Colorado, 17-20 August 1992)

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INTRODUCTION

A. Background and objective

1. At its forty-fourth session, in resolution 44/46 of 8 December 1989, the General Assembly endorsed the participation of the United Nations in the International Space Year (ISY), 1992. One of the major themes of the United Nations ISY activities is management of the resources of the Earth and its environment.

2. Over the last few years, some of the most important technical advances in environmental sciences have been in remote sensing. Innovations in hardware, software, and data networking have made remote sensing perhaps the most important and effective method of gathering and analysing information on the Earth system. This type of information is needed by all countries, and in particular by developing countries, for programmes of social and economic development.

3. As a part of United Nations-ISY activities, the United Nations and the Government of the United States of America co-sponsored the International Conference on Remote Sensing for Resource Management, Environmental Assessment and Global Change Studies: Needs and Applications of Developing Countries. Sponsoring agencies were the United Nations Office for Outer Space Affairs, the United States National Aeronautics and Space Administration (NASA), the United States National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey (USGS), and the Consortium for International Earth Science Information Network (CIESIN).

4. The objectives of the Conference were to examine the issues faced by developing countries in their efforts to contribute to the development and utilization of remote sensing technology and to address the role of satellite remote sensing in resource management, environmental assessment and global change studies. The Conference also discussed existing data sources, their accessibility, the availability of necessary data, the needs of developing countries and the role of remote sensing in meeting these needs.

5. The present report, which covers the background, objectives and organization of the Conference as well as a summary of presentations, discussions and conclusions, has been prepared for the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee by the United Nations Office for Outer Space Affairs in cooperation with the relevant United States Government organizations. Participants will report to the appropriate authorities in their respective countries.

B. Organization and programme

6. Professionals in the fields of remote sensing applications such as resource management, environmental assessment and global change studies were invited to the Conference by the United Nations. The Conference was also

publicized in major remote sensing journals and at remote sensing-related conferences. Forty-one professionals from the following countries and organizations participated as speakers in the Conference: Argentina, Bangladesh, Brazil, Chile, China, Czechoslovakia, Egypt, Ethiopia, France, Hungary, India, Israel, Jamaica, Mexico, Morocco, Nigeria, Pakistan, Poland, Saudi Arabia, Syrian Arab Republic, Thailand, the United States of America, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP) and the United Nations Office for Outer Space Affairs. One hundred and fifty-five participants attended the Conference; there was an active exchange of views among the participants.

7. The Government of the United States of America defrayed the cost of international air travel as well as the daily subsistence allowance for 23 participants and provided the conference facilities and rooms.

8. Welcoming and keynote addresses were given by Mr. John McElroy, Chairman of the Panel of Experts on Earth Science and Technology, Space Agency Forum on International Space Year (SAFISY); Mr. Albert Sellman, Director of International Service, CIESIN; Mr. Anthony Janetos, NASA; and Mr. Adigun Ade Abiodun, Expert on space applications, United Nations Office for Outer Space Affairs.

9. The programme of the Conference was designed jointly by the United Nations Office for Outer Space Affairs, NASA, NOAA, USGS and CIESIN. The Conference consisted of panel discussions and poster sessions in which audience participation was encouraged. The full programme of the Conference is contained in the annex to the present report.

I. SUMMARY OF PRESENTATIONS AND DISCUSSIONS

A. Existing data sources for resource management, environmental assessment and global change studies

10. The monitoring of various Earth system parameters is a vital element of resource management and global change studies. For instance, such data is required to develop global change models, but data alone do not provide all the required information. Analysis and integration of the data are also needed.

Atmospheric data-sets

11. Primary atmospheric data sources comprise of space-based, aircraft-based and ground-based observations. In many cases NASA Earth Science data are being transmitted from existing institutional facilities to one of the Distributed Active Archive Centres (DAAC) that will comprise the Earth Observing Data and Information System (EOSDIS). In some cases data-sets from a mission, instrument or experiment may be archived at more than one location. Some data-sets are currently available only to the principal investigators, but broader access is planned in the future.

12. In addition to the existing data sources, presentations were made on the following new or emerging data-sets: the Earth Observation System Pathfinder data-sets; the Greenhouse Effect Detection Experiment (GEDEX) CD-ROM; GEOSCOPE: an Interactive Global Change Encyclopedia; the SAFISY Polar Stratospheric Ozone Working Group; the Total Ozone Mapping Spectrometer (TOMS)/Meteor; and the Upper Atmospheric Research Satellite (UARS).

13. Developing countries have the opportunity to contribute to the programmes by providing national data to international programmes that are integrating such data into uniform global databases, and by providing ground-based validation of satellite-derived measurements.

Oceanographic database

14. The global oceanographic database that is being assembled by the international community is making a vital contribution to studies of environmental and global change. The historic oceanographic database has a value that is more than the sum of the goals of original experiments. Data from many investigations provide the necessary record of the historic broad-scale oceanographic variability needed to evaluate the significance of any future observed changes.

15. Because acquiring oceanographic data is both expensive and time consuming, an international cooperative effort to collect, archive, distribute and exchange historic and contemporary oceanographic data is needed. National oceanographic data centres and related organizations exist today in almost 40 countries.

16. When data users and researchers seek environmental data, it is sometimes difficult to determine what is available and how it can be obtained. Development of links to international data systems is necessary to improve developing country access to existing data. One such system, the International Directory Network (IDN), has been developed by the Committee on Earth Observation Satellites (CEOS), an international group that serves as the focal point for international coordination of Earth observation activities. IDN allows a user to determine how the data, along with other supporting information, can be obtained. The combination of low-unit cost and high data volume makes CD-ROM an efficient medium for providing large data-sets to researchers and other customers.

17. Because climate change involves relatively low frequency temporal variations, even limited observation programmes over small areas can make very important contributions to climate change and global investigations involving oceanographic measurements. Another role for local or regional oceanographic measurements is in the calibration and evaluation of remotely sensed data from satellites. Developing countries can make important contributions in this area by providing oceanographic data from their region to global data collection efforts and by using data archived and made available by the international community for their own research programmes.

Land data-sets

18. Many of the requirements for remotely sensed and thematic data that portray conditions on the land surface are related to international efforts to describe, monitor and predict the environmental effects of natural processes and human activities. To meet these needs, continental and global data-sets are being produced from a variety of remote sensing and earth science satellites.

19. Data from satellite and airborne platforms provide important information about the characteristics of the land surface and the processes which operate thereon. When interpreted in isolation, as well as in combination with other land-related data, they provide abundant information useful for global change research, resource management, environmental assessments and other Earth science applications.

20. The National Land Remote Sensing Archive managed by the Earth Resources Observational Satellite Data Center of the United States Geological Surveys is the primary storage and distribution facility for global Landsat data and Large Area Coverage-Advanced Very High Resolution Radiometer (AVHRR) data. Landsat, AVHRR, EOS and the remote sensing programmes of other countries such as the French Experimental Earth Observation System (SPOT) and the Japanese JERS-1, will also provide information needed to assess the effects of human activities on the environment.

21. Thematic data describing the types, geographic distribution, and extent of land form, cover and use ar rapidly becoming available for major portions of the Earth's surface. These data complement remotely sensed data and their derivatives in applications that address domestic and international environmental issues. Internationally sponsored projects such as the World Soil Resources Map published by FAO, are good examples of emerging thematic data-sets that can be incorporated into the global land characteristics database conceptualized by the International Geosphere-Biosphere Programme (IGBP).

22. The abilities of researchers and local managers in developing countries to contribute to the development of global land databases would be enhanced by improving availability of existing land data for monitoring regional conditions and managing domestic resources and by expanding access to training and facilities for processing the data.

Other data sources

23. The International Council of Scientific Unions (ICSU) has organized five World Data Centres (WDCs): WDC-A in the United States, WDC-B in the former Commonwealth of Independent States, WDC-C1 in Europe, WDC-C2 in Japan and WDC-D in China. The branches of the WDC system are coordinated by the ICSU Panel on World Data Centres, which consists of a bureau of principal officers and representatives of each of the major WDC groupings (A, B, C1 and C2) and a membership of representatives from various ICSU organizations.

24. There are currently 39 WDC discipline centres within WDC-A, WDC-B, WDC-C and WDC-D, and several others are in the process of being established. The disciplines represented are meteorology, oceanography, solar-terrestrial physics, solid earth geophysics, marine geology and geophysics, glaciology, seismology, rockets and satellites, rotation of the Earth, tsunami, Earth tides, sunspot index, geomagnetism, Sun-Earth relationships, solar activity, soil geography and classification, recent crustal movements, airglow, aurora, cosmic ray, ionosphere and nuclear radiation.

25. The WDC System faces a number of challenges in the future. The past five years or so have seen a curious change in the way that both scientists and administrators view data. In the IGY, and the immediate years following, data were perceived to be of marginal importance, and international data exchange proceeded with few hurdles. Now, partly because of the cost of modern data collection platforms, partly because of the amount of data being collected, and partly because of an increasing emphasis on the study of global problems, data have suddenly acquired a value that they never had before. This has affected different countries in different ways. Some Western countries have decided to commercialize certain types of data, particularly satellite remote-sensed data of the Earth. New data centres have been established to distribute the national data, both so that the countries can get full credit for their data collection activities and so that they can make some money from selling the data that they own. Others are contemplating using at least some of their data resources as a means of obtaining hard currency. None of these new attitudes are fundamentally unsound, but together they are threatening to impede the free and open exchange of data that so characterized the IGY years.

26. In another area, the role of developing countries in the WDC System has been becoming more problematical. Developing countries have been eager to send their data to the WDC System because of the international recognition that it gives their data collection programmes. This has often given their programmes local stature and helped in obtaining funding for them. However, there is another aspect to this activity that is beginning to become apparent. The WDCs are placed in developed countries, and the bulk of research into global problems also takes place in developed countries. Developing countries are often concerned mostly with local or regional problems. The result to this is that "international data exchange" is often a one-way flow of data from the developing countries to the developed. This has at least the potential for creating resentment in the less-developed world.

27. Programmes for the study of causes of global environmental change are relatively mature. Programmes for the study of the effects of global change are relatively new. This is particularly true of the effects of global change on human health, which are especially critical in many developing countries and other high-risk regions of the world.

28. Many existing data-sets, including world-wide data on mortality, mobility, nutrition and sanitation, are relevant to understanding the effects of global change on human health. However, these data are typically not collected as part of global change studies, and the global change research community is generally not aware of these data-sets.

29. Major collections of health data relevant to global change research and mechanisms to make those data-sets available are needed. Those data-sets should be integrated with physical science data, particularly remotely sensed satellite data.

United Nations Environment Programme - Harmonization of Environmental Measurement project

30. In 1989, UNEP and the Government of Germany established the cooperative Harmonization of Environmental Measurement (HEM) project. The main target of UNEP-HEM is the standardization and harmonization of nomenclature, measurements and other essential information in environmental science and programmes.

31. Harmonized information will be distributed through a modern electrical information system, called HEMIS, which can be run on standard personal computers using CD-ROM.

Space Agency Forum for International Space Year

32. SAFISY was established in New Hampshire, United States of America, in May 1988 in order to coordinate and collaborate with the ISY activities of national space agencies or equivalent bodies around the world. SAFISY membership has grown to 29 members and 10 affiliated members and includes all space-faring nations. SAFISY has met annually since 1988.

33. The SAFISY Panel of Experts on Earth Science and Technology has established projects in two areas. "Space Data for Global Change" consists of 10 projects which were designed to improve understanding of global change phenomenon, for example the greenhouse effect detection and monitoring changes in the ozone layer through the use of remote sensing data. "Global Change Outreach" projects have attempted to make available to the public a global change encyclopaedia, atlas, and promotional video tape. Each project has its lead agencies or countries.

B. Resource management and global change information needs of developing countries

Asia

34. Developing countries in Asia, which possess roughly three fifths of the world's population, are facing tremendous problems of overpopulation, deforestation, desertification, overgrazing, soil erosion and environmental pollution. These problems are complicated by natural disasters such as floods, typhoons/cyclones, storm surges, droughts, earthquakes and environmental degradation caused by human activities.

35. Satellite-based remote sensing data offer the unique advantages of providing coverage of a large area with a synoptic view, as well as providing repetitive coverage of the same area at regular intervals. Multi-temporal and multi-spectral remote sensing data could play a vital role in the management, assessment and monitoring of agriculture, forest, water, marine, geologic and mineral resources.

36. The capability of meteorological satellites and remote sensing satellites has generated extensive information on the environment of the Earth. This has generated extensive awareness among all people about the availability of such information for effective management of natural resources.

37. In some countries, Governments have given high priority to remote sensing because political leaders realize the technology is quite useful. But other countries are hesitant to employ remote sensing technology because they are not aware of its utility and because they are not certain whether acquisition and analysis of remote sensing data is a cost-effective method to meet national needs.

38. India has two operational remote sensing satellites (IRS-1A and IRS-1B) and will launch three more satellites in the series. Various Indian government agencies and non-governmental institutions also utilize data from other satellites such as NOAA, Landsat, SPOT, ERS-1, Seasat and Insat.

39. While many developing countries have investigated the utility and applications of remote sensing, several factors prevent many countries from fully benefiting from remote sensing technology. These include the lack of capital/operating cost, limited resolution, dearth of trained manpower, inappropriate and incomplete technology transfer and inadequate interfaces between decision makers, planners and technical personnel.

40. In order to utilize fully the available satellite remote sensing data, considerable efforts are required in both developing and developed countries. Scientist and expert exchange programmes should be organized. In India, the Department of Space has established the Sharing of Experience in Space (SHARES) programme for scientists from developing countries.

41. Books and journals on remote sensing, which can be very useful in developing countries, are quite expensive. A systematic cooperative effort to make these materials available at low cost in local or regional languages is urgently needed.

42. The integrated Remote Sensing and Geographic Information System (RS-GIS) could be an efficient tool for resource management and disaster monitoring on the global scale in general and in Asian perspectives. The use of RS-GIS in conjunction with conventional data will help Asian countries establish policies for environmentally sound and sustainable development (ESSD) through rational management and monitoring of natural resources, the environment, and natural disasters.

Africa

43. One of the greatest problems facing African countries is their inability to feed rapidly increasing populations. In Nigeria, for example, there is widespread poverty despite abundant natural resources. This problem is further compounded by large-scale environmental and resource degradation. Of all the regions of the world, Africa is probably the only region where Governments and citizens know very little about the quality, quantity, location and the current status of natural resources utilization.

44. Several agencies and programmes established to transform African agriculture often rely on external models without due consideration for the micro-ecological conditions, the local knowledge systems and institutional arrangements. General awareness of the need for sustainable development and management of the continent's natural resources has not been accompanied by the need for the generation and organization of information on current resource conditions.

45. Satellite remote sensing has tremendous potential for providing the information necessary for resource management. Programmes for satellite remote sensing for resource management have been organized by the Africa Remote Sensing Council (ARSC), the African Association of Cartography (AAC) and the African Organization of Cartography and Remote Sensing (AOCRS).

46. International organizations such as FAO, UNEP, the World Bank, UNDP, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Office for Outer Space Affairs, and developed countries through the European Community, the European Space Agency, the United States Agency for International Development and the Government of France, have conducted international cooperative activities with African countries. These programmes, though, have not been adequately coordinated, resulting in duplication and overlapping.

47. There are many existing and proposed programmes which must be well organized and coordinated. They include the National Environmental Action Plan (NEAP), the Global Environmental Facility (GEF), the Global Coalition for Africa (GCA), existing regional remote sensing centres, the United Nations Office for Outer Space Affairs proposal to establish Centres for Space Science and Technology and Education in developing countries, the Agenda 21 programme of the United Nations Conference on Environment and Development, and the African Environmental Project Preparation Facility (EPPF).

48. Although there are many practical applications for remote sensing technology, it has not been put to widespread use in many African countries. This is because many decision makers and senior civil servants are not aware of the possibilities and relevance of the technology to resource and socio-economic development.

49. There are not enough researchers or engineers skilled in remote sensing technologies and related disciplines. This is due primarily to the lack of adequate local opportunities for education and training in the field of remote sensing. Many countries have failed to realize that development cannot be imported and that it must be consistent with human dignity, which is hard to preserve in conditions of dependence on others and disrespect for indigenous culture.

50. The spectral bands and the channels selected for observation are determined by the parameters which the owner of a satellite system wants to observe, measure or collect. Therefore, much information needed by developing countries is not acquired.

51. In order to ameliorate the above conditions, Governments should: (a) recognize the contribution which the development and application of remote sensing can make towards the alleviation of economic problems; (b) prioritize their requirements and adopt an adequate level of technology; and (c) strengthen education and training in the field of remote sensing. Professional organizations in African countries should: (a) strengthen their understanding of existing remote sensing technology and technological advances; and (b) increase cooperation in order to influence regional Governments in formulating appropriate policies. International organizations and specialized national agencies should support policy development and intervention in all the above areas.

Latin America

52. Recent international conferences, such as the United Nations Conference on Environment and Development, held at Rio de Janeiro, Brazil, in June 1992, have emphasized the need for participation of all countries to evaluate and solve global environmental problems. Satellite remote sensing technologies and geographic information systems appear to be the most viable tools for carrying out such evaluations.

53. The Latin American countries, among other developing countries, face local and regional problems that must be solved before they can actively participate in global programmes. The capacity to locally evaluate involved phenomena must be enhanced in each country, or group of countries. This implies the necessity of the reception and acquisition of considerable amounts of satellite data and other types of data; the connection to high-speed telecommunication networks, as well as the creation of large databases that will integrate the observations of individual countries and those of the satellites.

54. The participation of Latin American countries in global environmental change studies will not be complete until they design, manage and operate their own remote sensing satellites. Brazil and Mexico are actively engaged in the development of communication satellites. They are currently in the early developmental stages of developing indigenously remote sensing satellites.

55. Brazil is a country of continental dimension with great ecological, climatic and cultural variety. The forest in Brazil holds one fifth of the planet's biodiversity. The State Forest Institute of the State of Rio de Janeiro is developing a GIS for vegetation and urban expansion monitoring: the "SIG-VERDE Project". The objectives of this project are to systematize the available information for regional planning, deforestation control, ecosystem surveys, urban expansion and vegetation monitoring.

56. The systematic monitoring of terrestrial vegetation, snow covered areas and sea surface temperatures could contribute to better management of natural resources and environmental assessment. Data from the NOAA-AVHRR system play an important role in such monitoring. AVHRR data have been very useful to scientists in Brazil, Chile and Argentina. All Latin American countries would benefit from development of a common AVHRR database.

Eastern Europe

57. Czechoslovakia became active in remote sensing activities in 1975 through an Intercosmos research programme. A good base existed through experience gained in photogrammetry and aerial photography but digital processing capabilities lagged behind due to the scarcity of data and the lack of useful processing equipment. There were also difficulties with gaining access to data because the images were provided by the Soviet Union only after a long delay and Landsat and SPOT data were not generally available and in any case were quite costly. Although the current level of knowledge is rather good, the operational implementation of satellite remote sensing is not sufficient to meet national needs.

58. The Remote Sensing Working Group of the Czechoslovakia Commission for Space Development is in charge of remote sensing activities in the country. About 20 institutes and 100 people are involved in the various remote sensing activities of the Commission. Decreasing prices of commercial satellite data and the recent easing of export restrictions, particularly those items previously on the Coordination Committee on Multilateral Export Controls (COCOM) licence list, have allowed Czechoslovakia to upgrade much of its hardware.

59. Environmental management and finding solutions to ecological problems are priority areas in the field of remote sensing applications. Experimental projects in forestry, agriculture, hydrology and land use planning have proven the mutually beneficial value of cooperation with foreign partners in the implementation of satellite remote sensing programmes.

60. In Poland, local development of a GIS, called SINUS, was prompted by the need for processing systems for remotely sensed data. The system was used to create the first computerized land use map of Poland. Twenty-five categories of land use/land cover were detailed on the map. The results of photo-interpretation were subjected to additional processing by the SINUS system, which was developed as a result of a four-year research programme. The system was also used to cartographically edit the land use data.

The Middle East

61. Environmental degradation in developing countries, particularly those in the Middle East, is a growing problem. Mismanagement of resources, industrial and pesticide pollution, urban encroachment onto previously agricultural land, contamination of water resources, waterlogging, desertification, coastal and terrestrial oil pollution, flooding of slum areas and climatic changes are among the problems faced by countries in this region.

62. In order to successfully manage resources and control pollution, an interdisciplinary database that integrates various physical, biological and socio-economic parameters is necessary. However, the data available on these parameters are usually available only intermittently and are often inaccurate.

63. Current efforts to develop an environmental decision support system for Alexandria, Egypt, and the area west of the Rosetta branch of the Nile River are an example of the value and need for environmental information systems in the region. This area is considered extremely vulnerable to environmental problems. The system is based on remote sensing and geographic information analysis techniques and involves components of satellite image processing, ground-based measurements, an air pollution monitoring network, coastal pollution sampling programmes and socio-economic surveys. Time series and change detection analysis are also in progress. Experts believe a network for collection, quality control and interpretation of available data that involves concerned universities and institutes is needed.

64. The Syrian Arab Republic established the General Organization of Remote Sensing (GORS) in 1986. GORS cooperates with government bodies such as the Ministries of Irrigation, Agriculture, Petroleum, Environment, Housing and Public Utilities and Higher Education, as well as with the General Establishment of Surveying and General Directorate of Meteorology. GORS has also promoted cooperative activities with all Arab countries and the League of Arab States as well as other foreign countries and international bodies such as Austria, Canada, Cyprus, Czechoslovakia, France, Germany, India, Italy, the Netherlands, Pakistan, Poland, Thailand, Turkey, the United Kingdom of Great Britain and Northern Ireland, the United States of America, and the United Nations. GORS has organized one internal course, two regional courses and two international symposia. In addition, the organization has implemented several studies and projects on the applications of remote sensing to geology, hydrology, hydro-geology, agriculture, environment, urban planning, and meteorology and has published many of these in remote sensing-related journals.

C. Opportunities for participation by developing countries

65. International resource management and global change programmes which provide opportunities for involvement by developing countries were introduced.

66. A presentation on NASA's Mission to Planet Earth programme was given. EOS, a main element of Mission to Planet Earth, is a long-term programme, planned for launch in the late 1990s, providing measurements over a 15-year period. EOS will provide the first long-term coordinated, simultaneous measurement of the interactions of the atmosphere, oceans, solid, and hydrologic and biogeochemical cycles. The project also will utilize French and Japanese satellite data. Examples of opportunities for participation by developing countries include: the NASA Global Change Research Graduate Student Fellowship which supports graduate student research in areas related to Mission to Planet Earth. International students at United States universities can participate in the fellowship programme. Opportunities are also available through NASA Research Announcements, for cooperative research area on a no exchange of funds basis.

67. The Agenda 21 agreement reached at the United Nations Conference on Environment and Development, which stressed the theme of strengthening human and institutional capacity, opens new opportunities for developing countries to take advantage of remote sensing technologies. It recognized the growing need for such technologies as well and improved the prospects that developing countries will receive financial and technical support to apply remote sensing and other space technologies for sustainable development programmes. Significant assistance will be available through the United Nations system, particularly through UNDP, which was designated the lead agency for capacity-building under Agenda 21.

II. CONCLUSIONS AND RECOMMENDATIONS

68. Conclusions and recommendations of the Conference were offered for each region covered (Asia, Africa, the Middle East, Latin America and the Caribbean, and Eastern Europe) and focused on existing barriers to translating the result of resource management and global change studies and the use of remote sensing for practical applications in developing countries; the applications areas that should be prioritized for possible collaboration among developing countries; and the most crucial data needs of developing countries for the next 5 to 10 years.

69. The importance of using space monitoring systems for resource and environmental management in developing countries was stressed. For example, data on desertification and soil are the most important information needed for land use and environmental problems.

70. People in developing countries are generally not aware of the usefulness of remote sensing. In particular, key decision makers often do not understand the importance of monitoring from space. The mass media could play an important role in educating people on the importance of remote sensing because it reaches many people. The publication by Governments, universities and other institutions of books on remote sensing, resource management or global changes in local languages is a practical step that can be taken to achieve this goal.

71. International cooperation between developing countries and developed countries is necessary for resource and environmental management in developing countries. In the current social and economic situation, if cooperative funds from the developed countries or international organizations are no longer available, developing countries must continue these activities.

72. It was pointed out that the integration of various kinds of databases into one database and the establishment of compatibility among software is necessary. However, such integration or database development is technologically quite difficult. The HEM project described above is one ongoing effort to standardize and harmonize existing databases. Progress has been made in the field of communications. Access to new technologies is also important.

73. Education and training are very important for the promotion of remote sensing activities in developing countries. There are still very few experts in developing countries. The United Nations has a plan to establish Centres for Space Science and Technology Education in Africa, Asia and the Pacific, Latin America and the Caribbean, and Western Asia regions. These Centres will initially assist in development of the necessary human resources in remote sensing and related technologies in order to support the environmental management, resource assessment and mapping needs of participating countries. The Centres will also strengthen the capabilities of institutions of higher learning, and national/regional remote sensing user assistance and training centres in the regions. The Centres will contribute to the promotion of remote sensing activities in developing countries.

Annex

PROGRAMME OF THE CONFERENCE

Date	Time	Subject	Speaker
Monday, 17 August	9.00 a.m.	Welcome and review of Conference objectives	A. Abiodun (United Nations)
	9.15 a.m.	Master of ceremonies	A. Sellman Consortium for International Earth Science Information Network (CIESIN)
	9.30 a.m.	Keynote address	J. McElroy Space Agency Forum on International Space Year (SAFISY)
	10.00-10.30 a.m.	Opening statement on the United States Committee on Earth and Environmental Sciences, Subcommittee on Global Change Research	A. Janetos United States National Aeronautics and Space Administration (NASA)
	10.50-Noon	Session 1: Existing data sources for resource management, environmental assessment, and global change studies	
		Part 1: Atmosphere, oceans and land research databases and resources	
		Global atmospheric data-sets	J. Lawless (NASA)
		Global oceanic data-sets	B. Douglas United States National Oceanic and Atmospheric Administration (NOAA)
	1.30 p.m.	Global land data-sets	D. Lauer United States Geological Survey (USGS)

Date	Time	Subject	Speaker
		Part 2: Other data sources	
	2.00-3.30 p.m.	The International Council of Scientific Unions World Data Centre System	M. A. Chinnery International Council of Scientific Unions (ICSU)
		Integration of health and remotely sensed data for studying the effects of global change on human health	V. Abreu (CIESIN)
	3.50 p.m.	Part 3: Space Agency Forum on International Space Year	
		Overview of resultant data-sets and products	J. McElroy (SAFISY)
	4.20 p.m.	Wrap-up interactive panel/audience discussion on existing data sources to meet user needs	
Tuesday, 18 August		Session 2: Resource management and global change	
		Information needs of developing countries: perspectives from Asia, Africa, Latin America and the Caribbean, Eastern Europe, and the Middle East	
	8.30-10.00 a.m.	Part 1: Asia	
		Moderator	S. Vibulstreth (Thailand)
		Applications of satellite remote sensing for needs of developing countries	P. P. Kale (India)
		Satellite remote sensing and its application to the needs of developing countries - Asian perspectives	M. A. H. Pramanik (Bangladesh)

Date	Time	Subject	Speaker
		Knowledge intensification-needs of developing countries in applications of remote sensing technology	S. Zaman (Pakistan)
	10.15-11.45 a.m.	Panel 2: Africa	
		Moderator	H. M. Hassan (World Bank)
		Potentials and constraints of applying remote sensing technology for the transformation of African agriculture	P. Adeniyi (Nigeria)
		National and regional centres in developing countries: visions and needs	M. B. Mehrez (Morocco)
	12.45-2.15 p.m.	Panel 3: Latin America and the Caribbean	
		Moderator	A. S. Grael (Brazil)
		The insertion of Latin American countries in environmental and global change assessment using remote sensing techniques	R. Alvarez (Mexico)
		Contribution of the United States National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) in resource management assessment and global change studies in the southern region of South America	D. A. Gagliardini (Argentina)

Date	Time	Subject	Speaker
		Remote sensing: an opportunity for cooperation among developing countries	G. Taylor (Jamaica)
	2.30-4.00 p.m.	Panel 4: Eastern Europe	
		Moderator	M. Baranowski (Poland)
		Remote sensing needs in Czechoslovakia	J. Kolar (Czechoslovakia)
		New requirements in remote sensing prompted by recent changes in Hungary	F. Sikhegyi (Hungary)
	4.15-5.45 p.m.	Panel 5: The Middle East	
		Moderator	M. El-Raey (Egypt)
		Application of remote sensing techniques for satellites in arid and semi-arid areas	J. Joseph (Israel)
		Remote sensing in Saudi Arabia	M. Tarabzouni (Saudi Arabia)
		Remote sensing in the Syrian Arab Republic	M. Koudmani (Syrian Arab Republic)
Wednesday, 19 August	9.00-Noon	Session 3: Applications to meet the needs of developing countries (poster session)	
		Using Landsat thematic mapper data to identify malaria areas	M. Rodriguez (Mexico)
		Geographic modeling of human carrying capacity from rainfed agriculture: Senegal case study	G. Gray Tappan (EROS Data Center)

Date	Time	Subject	Speaker
		The joint FAO/ESA test project to use the DIANA satellite communications system to allow access by developing countries to satellite derived information	J. Hielkema (FAO)
		Enhanced global change database for China	G. Wen (China)
		Application of the Medsat concept to issues of human health	B. L. Wood (NASA)
		Global student village	A. Sellman (CIESIN)
		NOAA-AVHRR data: low resolution, but a good alternative for developing countries	M. Farias (Chile)
		CIESIN's information cooperative: a public health perspective	V. Abreu (CIESIN)
		Overview of result and methodology of the CIESIN Pilot project programme	F. Sadowski (ERIM)
		The Kuwaiti oil fires: a comparative view - TM, AVHRR and SPOT imagery	
		The International Geosphere-Biosphere Programme multi-thematic database project for Africa	A. Faizone (France)
		The greening of the desert: land cover changes in the eastern region of the Abu Dhabi Emirate	J. Thomas (USGS)
		Session 4: Opportunities for participation by developing countries	

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Date	Time	Subject	Speaker
	1.30 p.m.	Part 1: Development of indigenous capability: centres for space science and technology education	A. A. Abiodun (United Nations)
	2.00-2.45 p.m.	Part 2: Opportunities for participation by developing countries	
		Moderator	D. Hausen (CIESIN)
		Mission to Planet Earth	J. Lawless (NASA)
		World Resources Institute	P. Thacher (World Resources Institute)
		Food and Agriculture Organization of the United Nations - mapping and land use monitoring activities	J. Hielkema (Food and Agriculture Organization (FAO))
		Regional institutes for global change research	C. Nierenberg (United States Committee on Earth and Environmental Sciences)
	3.00 p.m.	Part 3: Perspectives from the developing world	
		Moderator	P. Thacher (World Resources Institute)
		Asia	S. Vibulstreth (Thailand)
		Africa	H. M. Hassan (World Bank)
		Latin America and the Caribbean	A. Grael (Brazil)
		Eastern Europe	M. Baranowski (Poland)
		The Middle East	M. El-Raey (Egypt)

Date	Time	Subject	Speaker
	4.00-5.00 p.m.	Wrap-up - Interactive panel/audience discussion	A. A. Abiodun (United Nations) P. Thacher (World Resources Institute)
Thursday, 20 August		Site visits	
	8.15-1.30 p.m.	Tour 1: Boulder Laboratories	
		National Geophysical Data Center	
		NOAA Forecast Systems	
		Solar Forecast Center	
		National Snow and Ice Data Center	
		Tour 2: Denver facilities	
		Bureau of Land Management	
		Bureau of Reclamation	
		Bureau of Mines	